Diazinon and Chlorpyrifos as Urban Stormwater Runoff Associated Pollutants

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Review Water Quality Issues Associated with Urban Use of the Organophosphate Pesticides, Diazinon and Chlorpyrifos, That Leads to Urban Stormwater Runoff's Toxicity

Based on "Aquatic Life Toxicity in Stormwater Runoff to Upper Newport Bay, Orange County, California: Initial Results," Report G. Fred Lee & Associates, June 1997.

Urban Stormwater Runoff Toxicity

Urban Stormwater Runoff in Several Areas of California, Texas and Other Areas Has Been Found to Be Toxic to Some Zooplankton Such as *Ceriodaphnia*

Toxicity Due in Part to Diazinon and Chlorpyrifos

Under-Regulated Chemicals in Stormwater Runoff

Diazinon - No US EPA Water Quality Criterion
Chlorpyrifos - US EPA Water Quality Criterion - Not Enforced

US EPA FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act) Registration of Diazinon Has Not Properly Evaluated Stormwater Runoff Water Quality Impacts

Examples of Urban Stormwater Runoff Toxicity

Orange County, California:
San Diego Creek as It Enters Upper Newport Bay Had 8 to 10 Units of *Ceriodaphnia* Toxicity Associated with Stormwater Runoff in October-November 1996

50% of Toxicity Due to Diazinon and Chlorpyrifos
Other 50% Due to Unknown Causes

San Francisco Bay Region: Urban Creeks Contain *Ceriodaphnia* Toxicity Due to Diazinon
Some Street Gutters in Alameda County, California Residential Areas Contain >2,000 ng/L Diazinon

Central Valley, California: Stormwater Runoff from Urban Areas Is Toxic to *Ceriodaphnia* Due to Diazinon and Chlorpyrifos

Fort Worth, Texas: Urban Stormwater Runoff Toxic to *Ceriodaphnia* Due to Diazinon

Diazinon and Chlorpyrifos Toxicity

		Cal Fish and Game-Recommended Water Quality Criteria	
	Ceriodaphnia LC_{50}	4-day Average	1-hr Average
Diazinon	500 ng/L	40 ng/L (freshwater)	80 ng/L
Chlorpyrifos	100 ng/L 10 ng/L (saltwater)	20 ng/L (freshwater)	

Highly Toxic to Some Zooplankton Such as *Daphnids* and Benthic Organisms Such as Amphipods

Not Highly Toxic to Fish and Many Other Forms of Aquatic Life

Diazinon and Chlorpyrifos Use

Diazinon and Chlorpyrifos Widely Used by Commercial Applicators and Homeowners/Renters to Control Structural and Landscape Pests Including Termites, Ants, Fleas, Grubs, Beetles, Spiders, Chiggers, Earwigs, Silverfish, Cockroaches, Grasshoppers, Etc.

Orange County, California: 100,000 Pounds of Chlorpyrifos and Diazinon Used in Urban Areas in 1995

About 2 lb/yr in Stormwater Runoff Causes *Ceriodaphnia* Toxicity

Santa Clara County, California: 123,000 lb Chlorpyrifos and Diazinon Used in 1994

Persistence of Diazinon and Chlorpyrifos

In Soil:

Diazinon - "40 Days"

Chlorpyrifos - "30 Days"

Malathion - "1 Day"

Persistence Sufficient to Cause Ceriodaphnia Toxicity Associated with Urban Stormwater Runoff

Site-Specific Evaluation for Soil, Water, and Sediments Needed to Evaluate Persistence at a Particular Location

Dependent upon pH, Temperature, Moisture, Formulation, Other Factors

Sediment Quality Issues

Chlorpyrifos Tends to Sorb to Organic Carbon in Sediments
Water Solubility 0.4 mg/L

Found in Upper Bay Sediments of Upper Newport Bay, California near Where San Diego Creek Enters the Bay

Toxicity in Sediments Unknown

Diazinon Reported to Not Sorb to Sediments - Water Solubility 60 mg/L

Found in Urban Creek Sediments in San Francisco Bay Area

Sorbed? Toxic? - Sediments as a Buffer Source of Diazinon to Creek After Stormwater Runoff Event?

High Toxicity to Amphipods - May Be Cause of Unexplained Sediment Toxicity

Issue Needs to Be Examined for Water Quality Significance

Agricultural Use As a Source of Diazinon for Urban Area Stormwater Runoff

Application of Diazinon as an Orchard Dormant Spray in the Sacramento and San Joaquin Valleys, CA Causes Rainfall and Fogfall to Be Toxic to *Ceriodaphnia* in Many Areas at Considerable Distances from Application

Airborne Transport
Rainfall in Central Valley, CA after Dormant Spray Application Can Contain over 5,000 ng/L Diazinon - Toxic Level 500 ng/L

Toxic Pulses of Diazinon Lasting Several Weeks Pass through San Joaquin and Sacramento Rivers and Delta into Upper San Francisco Bay Each Winter
Likely Adverse to River and Delta Aquatic Life-Related Beneficial Uses
Due to Toxicity Magnitude and Persistence

Agricultural Use of Diazinon as Dormant Spray Also Causes Urban Areas and Highway Stormwater Runoff to Be Toxic to *Ceriodaphnia*

Alameda County, CA Found Local Airborne Transport as Part of Home Use

Regulatory Requirements for Control of Diazinon and Chlorpyrifos Toxicity

POTW's and Industrial Wastewater Discharge

No Acute Toxicity in Discharge/Mixing Zone

No Chronic Toxicity at Edge of Mixing Zone

NPDES Permitted Urban Area Stormwater Runoff Dischargers

Control Pollution of Receiving Waters for Stormwater Runoff to Maximum Extent Practicable Using Best Management Practices

Pollution Defined as Impairment of Designated Beneficial Uses

Could Require Protection of All Desirable Forms of Fish and Aquatic Life

Agriculture - No NPDES Permit Required
General Requirement of No Ambient Water Toxicity - Not Enforced

Control of Diazinon and Chlorpyrifos Toxicity

Small Amounts of Diazinon and Chlorpyrifos Use Responsible for Stormwater Runoff Toxicity

Orange County, California: about 2 lbs Out of the Estimated 20,000 lbs Used Annually Caused Toxicity in San Diego Creek

Toxicity Likely Difficult to Control

Need Detailed Forensic Studies of Sources of Toxicity and Toxic Components in Urban Area Stormwater Runoff

When Sources of Toxicity and Toxic Components Known, Examine Uses That Lead to Stormwater Runoff Caused Toxicity

Forensic Studies Should Be Funded by Pesticide Manufacturers, Formulators, Commercial Applicators, and Users

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Development of Diazinon and Chlorpyrifos Toxicity Control Strategy

Issues:

If Diazinon and Chlorpyrifos Causes Toxicity to or Impacts Several Types of Zooplankton and/or Fish Larvae, Require Control of Toxic Constituents to Eliminate Toxicity

Diazinon and Chlorpyrifos Apparently Toxic to Limited Number of Types of Zooplankton and Benthic Organisms

Additional Study Needed to Determine Water Quality Significance of Toxicity to Fisheries-Related Beneficial Uses of Concern to Public

Diazinon and Chlorpyrifos Are of Significant Value to Public for Pest Control

Determine Water Quality Significance of Toxicity
Urban Streams - Cannot Assume Toxicity Significant to Water Quality

Receiving Waters for Urban Streams and Stormwater Runoff
Rivers, Bays, Lakes, Ponds, Wetlands, Estuaries and Ocean

Assess Whether Toxicity Significantly Adversely Impacts Numbers, Types, or Characteristics of Desirable Forms of Aquatic Life

Determine Significance of Toxicity through Use of Best Professional Judgement, Non-Numeric Weight-of-Evidence Evaluation Based on:
Magnitude, Fate/Persistence, Duration of Aquatic Life Exposure, Transport Time in Creek, River and Bay/Lake Plumes, Type of Organisms Impacted, Importance of Organisms as Component of Food Web for Higher Trophic Level Organisms, Duration of Impact, etc.

Need to Develop Technical Guidance on How to Determine if Toxicity in Specific Waterbody Is Significant to Water Quality

If *"Ceriodaphnia"* Toxicity Judged Significant - Determine Cause of Toxicity

Use Guided TIEs, PBO Dilution Series Toxicity Tests, ELISA Analyses, etc.

Assess Amount of Toxicity Due to Diazinon and Chlorpyrifos

Use TIEs to Identify Cause of Non-Diazinon and Non-Chlorpyrifos *Ceriodaphnia* Toxicity

Potential Role of Chromium VI - Toxic to *Daphnia* at <0.5 µg/L

Through Forensic Studies Using Specific Toxic Chemical and Toxicity Measurements at Various Locations in Watershed, Determine Source of Toxicity

Examine Use/Activity Leading to Toxicity in Runoff Waters from Specific Area

Develop Toxicity and Specific Chemical Control Programs to Reduce [illegible], Where Possible, Eliminate Stormwater Runoff-Associated Toxicity That Is Significantly Adverse to Beneficial Uses of Receiving Waters for Runoff; Options:

Educate Users on Types and Manner of Use That Lead to Stormwater Runoff-Associated Toxicity
Need Studies to Define These Conditions

Restrict Certain Types of Uses That Lead to Urban Area Stormwater Runoff Toxicity

Reformulate Diazinon and Chlorpyrifos so Their Use Does Not Lead to Significant Stormwater Runoff-Associated Toxicity

Ban Use of Chlorpyrifos and Diazinon in Areas Where Stormwater Runoff -Associated Toxicity Is Judged to Be Significantly Adverse to Receiving Water Beneficial Uses

Assessment of an Urban Stormwater Runoff Aquatic Life Toxicity Water Quality Problem

Potential Water Quality Problems Associated with Laboratory-Measured Aquatic Life Toxicity Occur Where the Toxicity Impacts the Numbers, Types and Characteristics of Desirable Forms of Aquatic Life of Concern to the Public

Regulatory Requirements on Urban Area Street Stormwater Runoff Toxicity Not Definitively Defined

Control Pollution (Use-Impairment) to Maximum Extent Practicable Using Best Management Practices

Water Quality Problem Cannot Be Evaluated Solely by Measurement of the Concentration of a Pesticide Such as Diazinon or *Ceriodaphnia* Toxicity in Standard Toxicity Test

Assessment of an Urban Stormwater Runoff-Caused Significant Aquatic Life Toxicity Water Quality Problem

Toxicity Impacts Based on a Measured Level of Toxicity for a Sufficient Duration of Exposure to Be Adverse to an Organism

Toxic Conditions Defined by Toxicity - Duration of Exposure Relationship

Each Organism Type, e.g., *Ceriodaphnia*, Has a Certain Toxic Response - Duration of Exposure Relationship for a Particular Chemical

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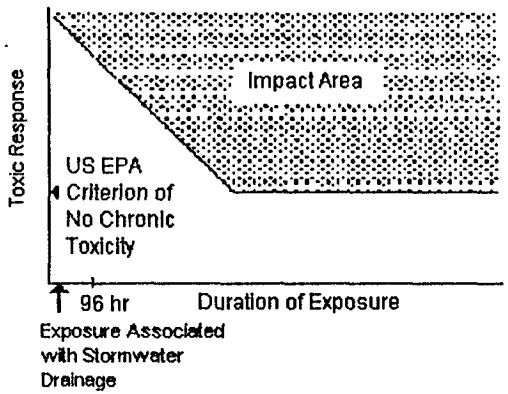
Toxicity - Duration of Exposure Relationship

Aquatic Toxicology



Stippled Impact Area Represents Conditions in Which Magnitude of Toxicity-Duration of Exposure Is Sufficient to Be Adverse to the Organisms

Laboratory Test Conditions Must Match Field Conditions of Toxicity-Duration of Exposure

Duration of Exposure Issues

Necktonic Organisms

Are Fish Attracted - Repelled by Water Containing the Toxicant(s)?

If Repelled - Can They Escape from Toxicant?

Usually Larval/Sensitive Forms of Fish Are Essentially Planktonic

Limited Ability to Control Position

Planktonic Organisms

Position Largely Controlled by Water Motion

May Be Able to "Hide" in Low Velocity Areas

Longer Exposure to Toxic Conditions Possible

Those That "Hide" during Runoff Event May Be Important to Restocking Stream/Area

Additional Toxicity - Duration of Exposure Issues

Some Urban Stormwater Runoff Has Been Found to Contain Short-Term, Greatly Elevated Spikes of Toxicity in the First Flush Runoff

Spikes of Toxicity Last Few Minutes to Few Hours - Could Readily Be Missed by Normal Sampling

Toxicity Is Not Representative of Average Conditions During Typical First Flush Event

Water Quality Significance of Toxicity Spikes Unknown

Latent Toxicity Found

Organisms Exhibit Toxic Effects Several Days after Exposure to Toxic Conditions While Organism in Non-Toxic Waters

Needs Further Investigation

Assessing Water Quality Significance of Toxicity

Normally Consider Direct Toxicity to Fish and Shellfish, Including Larval Forms, of Water Quality Significance That Requires Control

Also Consider Toxicity to Substantial Parts of Zooplankton Population of Water Quality Significance, That Requires Control

For *Ceriodaphnia* Toxicity Associated with Urban Area Stormwater Runoff of Short Duration

Linkage between Water Column & Sediment Toxicity and Significant Water Quality Impacts to Higher Trophic Level Organisms Less Well-Defined

Issue That Must Be Resolved: Does Reduction in Numbers of a Certain Component of Food Web for Limited Period of Time Significantly Adversely Affect Numbers, Types or Characteristics of Desirable Forms of Aquatic Life Such as Game Fish and Shellfish

Is There Substitute Fish Food That Can Sustain System Populations during Time of Toxic Pulse Impacts Associated with Stormwater Runoff Event?

Current Status of Diazinon/Chlorpyrifos *Ceriodaphnia* Toxicity in Urban Stormwater Runoff Pollution

Sufficient Concentrations of Diazinon & Chlorpyrifos Found in Stormwater Runoff to Waterbodies, Urban Creeks and Near-Shore Waters of Receiving Waters for Stormwater Runoff to Be Toxic to *Ceriodaphnia* under Standard Test Conditions

Potential for Water Quality Problem Exists - Likely Potential Problem Not Confirmed

Before Significant Efforts Are Made to Develop Use-Restrictions for Diazinon and Chlorpyrifos beyond Good Housekeeping and Conservative Use in Accord with Label, Should Evaluate Whether Critical Toxicity-Duration of Exposure Conditions Exist in Urban Creeks, Ponds, Bays, Lakes, Estuaries and Near-Shore Marine Waters to Result in Potentially Adverse Impacts on Aquatic Life-Related Beneficial Uses

Inadequate Information Available Today to Justifiably Claim That Significant Potential Water Quality Problem Exists Due to Diazinon & Chlorpyrifos in Urban Area Stormwater Runoff

Likely Will Be Significant Water Quality Problems Due to Diazinon/ Chlorpyrifos Toxicity in Some Urban Area Stormwater Runoff Situations
Rare or Common?

Must Conduct Intensive Studies to Develop Needed Information to Evaluate with Best Professional Judgement/Weight-of-Evidence Approach, Whether Significant Toxic Conditions Exist in Various Types of Urban Stormwater Runoff Situations to Confirm That There Is Significant Potential for Water Quality Use-Impairment Due to Stormwater Runoff-Associated Constituents Such as Diazinon and Chlorpyrifos

Locations at Which Real Water Quality Problems Occur Will Likely Be Limited to Certain Types of Receiving Water Situations

Those Situations Should Be Defined and Receive Highest Priority for Evaluation

Diazinon & Chlorpyrifos Manufacturers, Formulators, Applicators, and Users Should Fund Independent, Peer-Reviewed Studies to Define Whether Diazinon and Chlorpyrifos Are Potentially Causing Significant Water Quality Impacts - Use-Impairments

Burden of Proof Should Be on Those Who Wish to Profit from the Use of These Chemicals, Not on Non-Using Public or Environment

Failure to Adequately Fund Needed Studies Should Result in Use Restrictions

Definition of Significant Water Quality Problem

If Unlimited Funds Were Available to Address Readily Discernable Water Quality Problems, Potential Water Quality Problems, and Other Social Problems, Then Society Could Possibly Determine That Diazinon & Chlorpyrifos Use Should Be Restricted to Control Toxicity in Urban Stormwater Runoff

However, Funds Available for Control of Readily Discernable Water Quality Problems and to Investigate Potential Problems Are Limited, and Diazinon & Chlorpyrifos Are Useful Chemicals to Large Part of Urban Population

Must Evaluate Whether Restricting Use of Diazinon & Chlorpyrifos Is Justified Based on Their Causing Significant Water Quality Problems/Use-Impairments in Receiving Waters for Urban Area Stormwater Runoff

A Determination of Significant Water Quality Problems/Use-Impairment Should Involve Adverse Impacts on the Numbers, Types, and Characteristics of Desirable Forms of Aquatic Life of Concern to Public

Social Decision - Public Needs to Better Understand Potential Magnitude of Problem to Aquatic Resources of Interest to It

Diazinon and Chlorpyrifos Have Existed in Urban Area Stormwater Runoff and Receiving Water for Many Years

Therefore, If Problem Is, in Fact, Real for Particular Runoff Situation, Those Receiving Waters Where Problem Could Be Occurring Are Already Degraded

Issue Becomes - What Will the Improvement Be in Beneficial Uses of Receiving Water if Significant Restrictions Are Placed on Use of Diazinon & Chlorpyrifos in Urban Areas?

Important to Assess Whether Diazinon & Chlorpyrifos Are the Only Toxicants in Stormwater Runoff That Potentially Impact *Ceriodaphnia*-like Populations

In San Diego Creek Entering Upper Newport Bay Only about Half of Toxicity to *Ceriodaphnia* Found in Fall 1996 Was Due to Diazinon & Chlorpyrifos, Remainder of Unknown Cause

Could Control Diazinon & Chlorpyrifos Toxicity but Not Significantly Improve Receiving Water Beneficial Uses because of:

Limited Significance of Diazinon & Chlorpyrifos Toxicity to Beneficial Uses

Residual Toxicity Due to Other Constituents

Should Always Measure Level of Total Toxicity and Define, as Well as Possible, Its Cause through Appropriate TIEs and, Its Source(s) through Forensic Studies

Issues in Regulation of Diazinon and Chlorpyrifos

Should Use Pesticide in Accord with Label - Conservative Use, Proper Management of Residues
Need Education on Appropriate Use

Need for Immediate Control of Present Pesticide Use because of Imminent Hazard of Adverse Impacts of Toxicity?
No. Damage Already Done - New Significant Adverse Impacts Unlikely

Control New Uses and New Areas of Application which Could Result in Runoff to Ecologically Sensitive Systems

Organophosphate Pesticide Toxicity Long-Standing Problem if Real, Significant Problem Exists

Recommendation: Practice Good Housekeeping and Conservative Use
Determine if Water Quality Problems/Use-Impairment of Concern to Public is Occurring That Could be Controlled if Use Restrictions of Urban Pesticides were Implemented

Ecological Versus Water Quality Impacts

Ecosystems Resilient to Perturbations

Some Societally Socially Important Organisms, Such as Fish, May Able to Be Eliminated without Altering Functioning of Ecosystem

Water Quality Related to Beneficial Uses

Numbers, Types, and Characteristics of Desirable Forms of Aquatic Life

Includes Adequately Functioning of Ecosystem and Protection of Specific Types of Organisms Such as Game Fish, Endangered Species, Etc.

Includes Body Burdens of Hazardous Chemicals Such as Mercury and PCBs That, While Not Necessarily Adverse to the Aquatic Ecosystem, Are of Concern to the Health of People Who Consume Them

Chemical Ecology

Important to Properly Incorporate Aqueous Environmental Chemistry Into Evaluation of the Water Quality Impacts of Chemicals

Most Chemicals Exist in a Variety of Chemical Species, Only Some of Which Are Toxic/Available

Chemical Species Distribution Depends on Physical, Chemical, and Biological Factors

Many Other Factors, Such as Transport and Mixing That Impact Biological Species Also Impact Chemical Species

Aquatic Chemistry

Not Chemical Characteristics - Chemical Census

Often Cannot Infer Water Quality Impacts Based on Chemical Characteristics

Chemical Reactions

Thermodynamics (Energetics - Position of Equilibrium)

Kinetics (Rates of Reactions)

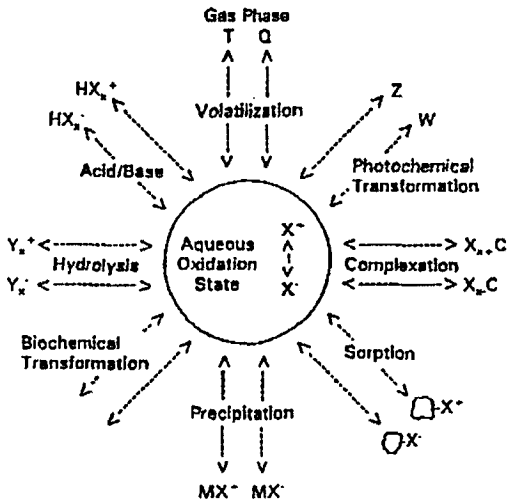
Transport - Advection, Mixing, Diffusion, Turbulence

Hydrology, Hydraulics, Hydrodynamics

Must Consider Solution - Dissolved and Particulate Forms

Suspended and Bedded Sediments

Aquatic Chemistry of Chemical Contaminants



Distribution Depends on Kinetics & Thermodynamics of Reactions in a Particular Aquatic System

Each Chemical Species Has Its Own Toxicity Characteristics
Many Forms Are Non-Toxic

Overall Assessment of Adequacy of Current Information on Water Quality Significance of Diazinon/Chlorpyrifos Toxicity In Urban Stormwater Runoff

Necessary Studies Have Not Been Done to Define Whether Toxicity or Potentially Toxic Concentrations of Diazinon or Chlorpyrifos Are Present in Urban Area Stormwater Runoff to Be Potentially Significantly Adverse to Designated Beneficial Uses of Various Receiving Waters

This Area Needs Attention

Conclusions and Recommendations

California Urban Creeks and Some Parts of Rivers, Bays, Estuaries, Ponds and Lakes Are Experiencing Aquatic Life Toxicity Due to Urban and Some Agricultural Uses of Diazinon and Chlorpyrifos

- Widespread Toxicity to *Ceriodaphnia* Caused by Diazinon and Chlorpyrifos Associated with Urban Area Stormwater Runoff
- Water Quality Significance of Toxicity Depends on Characteristics of Urban Creek and Receiving Waters for Stormwater Runoff and Creek Discharge
- Need Site Specific Studies to Determine Water Quality Significance of Diazinon and Chlorpyrifos Toxicity
- Need to Develop Guidance on Approach That Should be Followed to Determine, for Particular Creek or Stormwater Runoff/Receiving Water Situation, the Water Quality Significance of Diazinon and Chlorpyrifos and Other Causes of *Ceriodaphnia* Toxicity
- Need Forensic Studies to Determine Sources and Activities That Cause Diazinon and Chlorpyrifos Toxicity in Waters Receiving Urban Area Stormwater Runoff
- Need to Control Agricultural Use of Diazinon as Dormant Spray, to Eliminate Airborne Transport That Causes Rainfall and Stormwater Runoff to Be Toxic in Widespread Areas for Weeks at a Time

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in which they list some of their recent professional papers and reports devoted to public health and environmental quality aspects of domestic water supply water quality, water and wastewater treatment, water pollution control, and the evaluation and management of impacts of solid and hazardous waste. The major topic areas of this Web Site are:

- Landfills - Solid and Hazardous Waste Impact Evaluation and Development
- Water Quality Evaluation & Management for Wastewater Discharges and Stormwater Runoff
- Hazardous Chemical Impact - Superfund - Evaluation and Remediation/Management
- Contaminated Sediments - Aquafund - Water Quality Impact Evaluation and Management
- Domestic Water Supply Water Quality- Watershed Management
- Reuse of Reclaimed Wastewaters for Groundwater Recharge and Shrubbery Irrigation
- Excessive Fertilization/Eutrophication of Lakes, Reservoirs, Estuaries, and Marine Waters
- Sacramento River and Delta Water Quality Issues
- Upper Newport Bay, California Water Quality Issues

Water Quality and Solid & Hazardous Waste Landfills Evaluation and Management

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- Information on G. Fred Lee & Associates

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D-043723

Possibility of Copper-Caused, Non-Detected, Subtle Water Quality Impacts

While No Identified Water Quality Problems - Use Impairments Have Been Found – No One Can State With Certainty that No Subtle Problems Will Be Found in the Future

Evaluation Monitoring Requires that Funds Be Made Available to Search for Subtle Water Quality Use Impairments

Prioritize Water Quality Use Impairments - Focus on Most Important Problems

With Limited Financial Resources Available for Water Pollution Control, Focus the Funds Available on the Most Significant, Readily Discernible Water Quality Use Impairments

Search for More Subtle Problems

Conclusions

- Traditional Regulatory Approaches for Heavy Metals Such as Copper Fail to Reliably Incorporate Aquatic Chemistry of Regulated Constituents into Regulatory Approach
- Leads to Over-Regulation and Waste of Public and Private Funds in Unnecessary Waste Treatment Facilities/Control Programs
- Need to Shift Regulatory Approach from Control of Chemicals to Managing Water Quality of Concern to the Public
- Use Toxicity Tests to Determine if Toxicity Present. If Present, Determine Cause and Sources
- Urban Stormwater Runoff New Regulatory Area Where There Is Need to Integrate Use of Aquatic Chemistry and Toxicology to Define Real Water Quality Problems

Learned Discourses: Timely Scientific Opinions

Lee, G. F., and Jones-Lee, A., "Evaluation Monitoring as an Alternative to Conventional Stormwater Runoff Monitoring and BMP Development," *Learned Discourses: Timely Scientific Opinions, SETAC News* 17(2):20-21 March (1997).

Evaluation Monitoring as an Alternative to Conventional Stormwater Runoff Monitoring and BMP Development

G. Fred Lee and Anne Jones-Lee
G. Fred Lee & AssociatAes

There is growing agreement (Urbanos and Torno 1994; Herricks 1995; Lee and Jones-Lee 1994, 1996a) that conventional stormwater runoff monitoring for a suite of chemicals at the storm sewer outfall or edge-of-the-pavement is of limited value in defining real water quality problems caused by chemicals in stormwater runoff. There is also increasing recognition that conventional best management practices (BMPs) such as detention basins, filters, etc. are not real BMPs for controlling water quality use impairments in waterbodies receiving urban area street and highway stormwater runoff. An alternative monitoring and BMP development approach is "Evaluation Monitoring."

Evaluation Monitoring assesses the impact of stormwater runoff-associated constituents from a water quality use impairment perspective. Conventional monitoring develops chemical data via edge-of-the-pavement sampling and tries, usually with little or no success, to extrapolate to receiving water impacts. Evaluation Monitoring is a watershed-based water quality evaluation and management program in which the stakeholders concerned about water quality in a particular waterbody work together to define the water quality use impairments that are occurring in a waterbody and the cause of the use impairments. They then work to develop control programs to limit the amounts of the constituents responsible for the use impairments entering the waterbody of concern.

For example, many heavy metals and organics are of concern in urban area street and highway stormwater runoff because of their potential toxicity to aquatic life. Conventional stormwater runoff monitoring generates data that indicate that potentially significant elevated concentrations of heavy metals are present in urban area street and highway runoff. However, the chemical data developed from such monitoring cannot be used to determine whether the concentrations found in the runoff are in toxic, available forms and whether the toxicity associated with these constituents will be present at toxic levels in the receiving waters for a sufficient time to be significantly toxic to receiving water aquatic life.

Evaluation Monitoring measures the amount of toxicity in the stormwater runoff as it enters the waterbody of concern using U.S. EPA standard ambient water toxicity tests. Where potentially significant toxicity is found in the runoff waters entering a waterbody, site-specific studies are conducted to determine whether the toxicity in a stormwater runoff event is of sufficient magnitude and duration to be potentially adverse to the receiving water aquatic life. If such conditions are found, then through toxicity investigation evaluations (TIEs) the constituents responsible for the toxicity are determined and through forensic studies the sources of these constituents within the watershed are evaluated.

In the Evaluation Monitoring approach, rather than assuming that conventional BMPs, such as detention basins and filters, are effective in controlling potential water quality use impairments in the receiving waters for stormwater runoff, site-specific BMPs are developed to control real water quality use impairments to the maximum extent practicable (MEP). Typically, these BMPs focus on source control that manages the input of the chemical species of concern using BMPs to the MEP. These BMPs, in most cases, will be significantly different from the conventional stormwater runoff BMPs used today since they will focus on dissolved, toxic/available forms rather than particulate, non-toxic forms.

In order to manage water quality problems due to potential bioaccumulatable chemicals such as the chlorinated hydrocarbons and mercury, the focus of Evaluation Monitoring is on determining whether excessive concentrations of these chemicals are found in receiving water fish. Fish tissue analysis is used to determine whether there is a water quality problem due to excessive bioaccumulation. In contrast, conventional stormwater monitoring tries to extrapolate from the constituents in stormwater runoff to tissue concentrations. This approach is normally of limitedreliability since there are a variety of factors that influence whether a chemical constituent in runoff waters bioaccumulates to excessive levels in receiving water aquatic organisms. For example, for mercury, the conventional monitoring approach extrapolates from stormwater runoff mercury concentrations to receiving water concentrations of methylmercury which accumulate in fish tissue to excessive levels. Such approaches have limited reliability because of the complex aqueous environmental chemistry of mercury.

Evaluation Monitoring is a cost-effective, technically valid approach for evaluating whether regulated heavy metals and organics as well as unregulated constituents in urban area street and highway stormwater runoff are adverse to the designated beneficial uses of the waters receiving the runoff. The various potential water quality use impairments of concern such as aquatic life toxicity, domestic water supply, excessive hazardous chemical bioaccumulation, excessive fertilization, sanitary quality, petroleum hydrocarbon - oil and grease, litter, and excessive sediment accumulation or impacts are evaluated in the Evaluation Monitoring program in terms of their significance in impairing the beneficial uses of the waterbody (Lee and Jones-Lee 1996b,c).

Where significant receiving water beneficial use impairment occurs, the waterbody stakeholders work together to define through forensic analysis the sources of constituents responsible for impairment and then develop programs to control the impairment to the MEP. A three-year demonstration project is currently underway in Orange County, California for stormwater runoff water quality management in Upper Newport Bay. This program is being conducted in cooperation with the Orange County Environmental Management Agency and the Santa Ana Regional Water Quality Control Board as well as other stakeholders within the Upper Newport Bay watershed.

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Assessing Water Quality Impacts of Stormwater Runoff

G. Fred Lee, PhD, PE, DEE (Member)[1]
Anne Jones-Lee, PhD (Member)

Abstract

Current "water quality" monitoring of non-point source runoff typically involves periodically measuring a laundry list of chemicals in the runoff waters. This approach, while satisfying regulatory requirements, provides little to no useful information on the impact of the chemicals in the runoff on the real water quality - designated beneficial uses of the receiving waters for the runoff. There is need to focus water quality monitoring on investigating the receiving waters in order to assess whether the chemicals in the runoff are adversely affecting beneficial uses. This paper presents an evaluation monitoring approach for monitoring receiving waters that determines whether the runoff is a significant cause of water quality - use impairments. For each type of use impairment, such as aquatic life toxicity, excessive bioaccumulation of hazardous chemicals, excessive fertilization, etc., highly focused site-specific studies are conducted to determine the use impairment that is likely occurring due to a stormwater runoff event(s) and the specific cause of this impairment.

Introduction

There is growing recognition that domestic and industrial wastewater and stormwater runoff "water quality" monitoring involving the measurement of a suite of chemical "pollutant" parameters in discharge/runoff waters is largely a waste of money. For stormwater runoff, such programs generate more data of the type that have been available since the 1960's on the chemical characteristics of urban area, highway and street runoff. It has been known since that time that runoff from these areas contains a variety of regulated chemical constituents and

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Suggested Regulatory Approach

Do Not Regulate Based on Worst-Case Criteria/Standards Where Exceedances Require Establishing TMDLs

Use Exceedance of Criterion as an Indicator of Potential Water Quality Problems

If Exceedance of Water Quality Criteria Found for Potentially Toxic Chemicals, Allow Discharger/Source Option of Complying With the National Chemical Criteria or Demonstrating Lack of Biological Impact-Toxicity

Problems With Conventional Water Quality Monitoring of Stormwater Runoff

Conventional Monitoring of Runoff/Discharge Water for Suite of Chemical Parameters Produces Little Useful Information on Water Quality Impacts
Focus on Exceedance of Water Quality Criteria

Urbonas & Torno, ASCE Stormwater NPDES Related Monitoring Needs (1994) Conference Summary,

"Very little meaningful monitoring is being directed toward measuring the actual effect of stormwater discharges on the short- or long-term health of the environment. Furthermore, there is no consensus on how this monitoring should be done."

Roesner in Same Conference Discussion,

"....the course we are taking with the NPDES stormwater permitting program is going to cost municipalities a lot of money, but is not going to result in any significant improvement in the quality of our urban receiving water systems."

Factors that Must Be Considered in Translating Runoff Concentrations to Potential Aquatic Life Water Quality Impacts

Stormwater runoff

Need information:

- measured concentration of constituent during runoff event - concentration time profile
- discharge of the runoff waters during runoff event - hydrograph
- analytical chemistry of the method used for analyses - what chemical species are measured

Receiving waters

Physical factors - need information:
- Currents, tides - transport-advection
- Mixing-dispersion

Biological factors - need information:
- Duration of organism exposure to toxicant
- Organism movement - locomotion
  Diel migration
- Sensitivity to toxicants
- Organism assemblages - resident populations relative to habitat characteristics

Chemical factors - need information:
- Aquatic chemistry
  Kinetics and thermodynamics of reactions
  Additive, synergistic and antagonistic reactions and impacts
- Toxic and non-toxic, non-available forms
- Background concentrations of constituents of concern

Evaluation Monitoring As An Alternative to Conventional Water Quality Monitoring and Management

Need Alternative Monitoring/Evaluation Approach to Determine if Real Water Quality Use Impairments Are Occurring in Receiving Waters for Urban Stormwater Runoff

Metals and Many Other Constituents in Urban Area and Highway Stormwater Runoff in Particulate, Non-Toxic Forms

Episodic, Short-Term Exposures Occur with Stormwater Runoff Events

Rare that Real, Significant Water Quality Use Impairments Will Occur from Urban Area and Highway Stormwater Runoff-Associated Constituents

Evaluation Monitoring

Find a Real Water Quality Use Impairment in Receiving Waters for Stormwater Runoff that is Due to Stormwater Runoff-Associated Constituents

Rather Than Measuring Suite of Potentially Toxic Chemicals, Measure Toxicity in Runoff Waters and Receiving Waters

- If Significant Toxicity Found, Determine Its Cause through TIEs
- Determine Sources of Toxic Constituents through Forensic Studies
- Develop Control Programs for Toxic Constituents at Source

Technically Valid, Cost-Effective Approach

D—043726

Independent Applicability of Chemical and Biological Criteria/Standards and Effluent Toxicity Testing

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The National Environmental Journal
5(1):60-63 (1995)

In 1985 the U.S. Environmental Protection Agency (EPA) advocated a two-part approach for water pollution control involving chemical concentration-based effluent limits for those parameters for which water quality criteria had been developed and toxicity test-based effluent limitations. The chemical-specific component was designed to prevent exceedances of water quality criteria values in ambient waters receiving point and non-point source discharges or runoff; the water quality criteria were, in large part, developed to be chronic-exposure, safe concentrations for sensitive aquatic organisms. The toxicity test component was designed to indicate potential toxicity effects associated with an activity, to account for the possible presence of a toxic contaminant that did not have a water quality criterion, and to provide the opportunity for site-specific tuning of the chemical-specific criteria for synergism, antagonism, chemical availability, and exposure situations.

EPA has since expanded its recommended approaches to include a direct measure of biological characteristics (biological criteria) of surface waters. The biological criteria focus on the numbers, types and characteristics of organisms present downstream of a discharge or runoff compared with the numbers, types and characteristics expected based on the aquatic life habitat characteristics. A number of states have developed biological criteria and have been using them in water pollution control programs.

At a 1992 EPA workshop on water quality criteria and standards, EPA representatives revealed that the Agency would soon be releasing a position paper announcing the policy of "Independent Applicability." The June 1992 issue of EPA's "Newsletter Water Quality Criteria & Standards," however, stated that Independent Applicability is EPA's present position, and it is detailed in several documents. That inconsistency notwithstanding, the policy and/or practice of independent applicability and its ramifications for water pollution control in the country truly deserves a thorough examination.

The Problem with Independent Applicability

According to EPA in 1992, the three above-mentioned regulatory approaches for the regulation of toxics would be applicable to all waters, and the approach that was most "sensitive," (most limiting) for a particular waterbody would guide management. This led to many questions about how the policy would handle a situation in which:

- Biological studies of the receiving waters showed healthy and wholesome fish and other aquatic life populations, the same as those that would be expected based on habitat characteristics, and
- Short-term chronic toxicity testing of the waters in the region showed no aquatic life toxicity, but
- Numeric water quality criteria (or standards equivalent to them) were exceeded.

At that time, EPA stated that even under such circumstances, the discharger or source of runoff would have to implement control programs to eliminate the exceedances of the water quality criteria or standards, or change the standards. It was reported to be EPA's position under the policy of independent applicability to require that site-specific water quality criteria or standards be developed in order to justify not complying with EPA's water quality criteria, or more properly, state standards equivalent to those criteria.

It is appropriate to question the appropriateness of requiring dischargers and state regulatory agencies to develop site-specific water quality standards in response to that scenario (i.e., a situation in which it had been shown that there was no aquatic life toxicity in the receiving waters for the discharge/runoff and the populations of aquatic life in the region of expected impact were what would be expected based on habitat characteristics). There have been few attempts to develop site-specific water quality standards as outlined in EPA's Water Quality Criteria Handbook. As a consequence of the state of California Water Resources Control Board's adoption of EPA criteria as state water quality objectives (standards) in April 1991, a number of studies have been undertaken in California in an effort to develop site-specific objectives. More than $300,000 were spent in such effort in the San Francisco Bay area; more than $1.1 million were spent in efforts to develop site-specific criteria/standards for the Santa Ana River in southern California. However, as discussed below, the funds spent in trying to develop site-specific water quality objectives for copper in San

Human and Ecological Risk Assessment: Vol. 1, No. 1, pp. 5-11, 1995

Appropriate Use of Numeric Chemical Concentration-Based Water Quality Criteria

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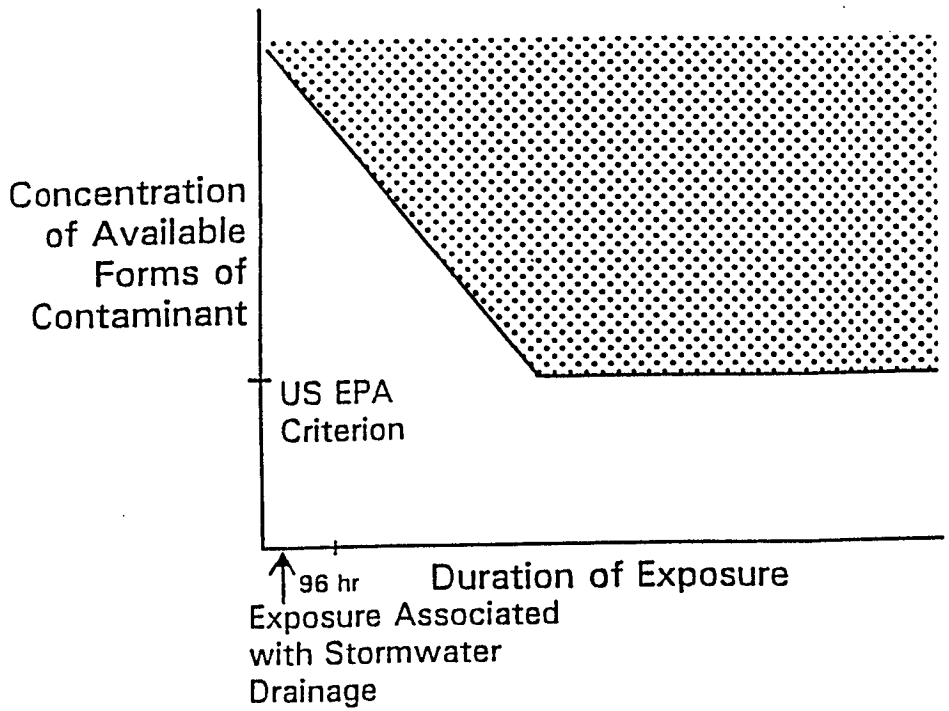
INTRODUCTION

Increasing attention is being given to the cost-effectiveness of chemical contaminant control programs established to reduce toxicity to aquatic life in the watercolumn and sediment, and excessive bioaccumulation of contaminants in aquatic life. Evaluation and control of chemical contaminants has generally focused on either the effects of the contaminant(s) on aquatic organisms (biological effects-based approaches), or on concentrations of individual chemical contaminants with extrapolations to their impact on aquatic organisms (chemical concentration-based approaches).

Owing to their comparative simplicity and ostensible ease of application, chemical concentration-based state water quality standards based on or equivalent to US EPA numeric water quality criteria are being increasingly relied upon as independently applicable regulatory tools for the assessment, protection, and/or enhancement of designated beneficial uses of aquatic systems. However, the present-day use of such criteria and standards largely ignores the aqueous environmental chemistry and toxicology of contaminants, the worst-case or near-worst-case foundation of those criteria, and the fact that there is a large body of contaminants for which numeric concentration criteria do not exist. Each of these factors diminishes the reliability of the extrapolation of chemical concentrations to impacts on aquatic organisms/beneficial uses of water, and tends to make them more stringent than necessary to protect designated beneficial uses of waters. That notwithstanding, the US EPA has adopted the policy of Independent Applicability for chemical concentration criteria in which chemical-specific concentration values are applied independent of biological effects-based approaches for regulating "water quality". They are presumed to be independently reliable even when they indicate an "effect" that is not supported by biological effects-based approaches, such as toxicity testing and actual measurements of bioaccumulation evaluated on a site-specific basis.

Aquatic Toxicology



US EPA Criteria List 1-hr-Average Maxima and 4-day-Average Maxima

Not Valid for Assessing Potential Impacts of Urban Stormwater Drainage

Urban Stormwater Runoff Water Quality Impacts
New Regulatory Area

US EPA 1990 Stormwater Runoff Water Quality Management Program Requires Controlling **Pollution** of Receiving Waters for Stormwater Runoff to the **Maximum Extent Practicable** Using **Best Management Practices (BMPs)**

Urban Area Streets and Highway Stormwater Runoff Contains Several Heavy Metals Such as Cu, Pb, Cr, Zn, Hg and As at Excessive Concentrations Compared to US EPA Water Quality Criteria

If Urban Stormwater Runoff Regulated to the Same Degree as Domestic Wastewaters–No Exceedance of Water Quality Standard Outside of Mixing Zone, Will Cost Urban Dwellers $1 to $2 per Person per Day

Must More Reliably Evaluate Real Water Quality Impacts of Stormwater Runoff-Associated Constituents

Rarely Are the Heavy Metals In Stormwater Runoff from Urban Area Streets in a Toxic-Available Form

Independent Applicability Policy

US EPA Adopted Independent Applicability Policy in Early 1990s
No Public Review

Requires Attainment of Chemically-Based Water Quality Criteria/Standards Even If Biological Assessments - Toxicity and/or Organism Assemblages Show No Impacts Due to the Chemical Present in Excess of Criterion/Standard

Leads to Administrative Exceedances of Criterion/Standard Without Adverse Impacts on Beneficial Uses of Water

Technically Invalid and Wasteful of Public Funds
Focuses on Chemicals Rather than Chemical Impacts
Ignores Purpose of Water Quality Management
Protection of Beneficial Uses

US EPA Announced Proposed Rulemaking
Possible Change Independent Applicability Policy

Water Effect Ratio Adjustment

Measure Toxicity of Copper in Standard Lab Water and in Bay Water, Use Ratio to Adjust Water Quality Objective

$$\text{Water Effect Ratio} = \frac{\text{Site Water } LC_{50}}{\text{Lab Water } LC_{50}}$$

Only Considers Short-Term Equilibration, Does Not Consider Total and Dissolved Slow Equilibration

Underestimates Water and Specific Chemical Form Impacts

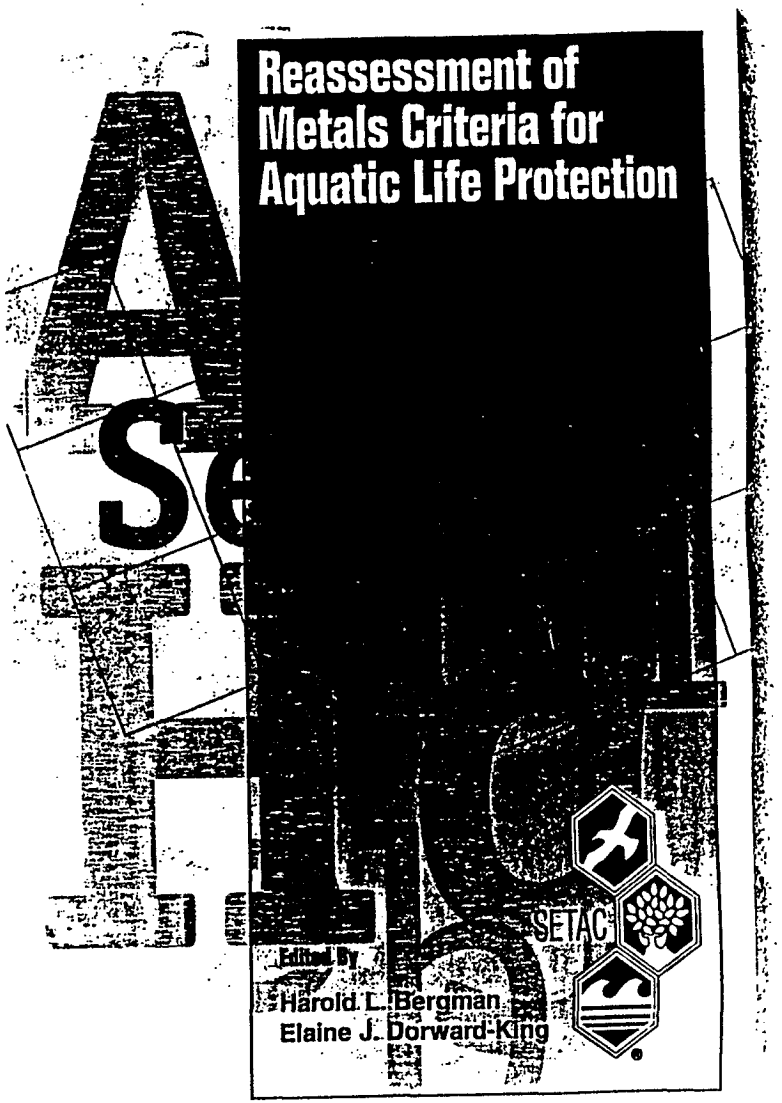
Relationship Between Analytical Chemistry and Water Quality

Poor Relationship Between Analytically Measured Concentrations and Water Quality Impacts

Purpose of Water Pollution Control
Protect and Where Degraded, Enhance Designated Beneficial Uses of Waterbody for Aquatic Life-Related Beneficial Uses

Cannot Use Chemical Analysis to Predict Toxicity
Must Use Bioassays - *Toxicity Test as Primary Regulatory Tool*

Need Research on Chemical Species Toxicity Test Results



Automobile Brake Pad Copper: Is There a Real Water Quality Problem? *An Example of an Inappropriate Approach for Developing a Stormwater Runoff Source Control BMP*

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June 1996

With the implementation of the US EPA national NPDES urban stormwater runoff water quality management program in 1990, stormwater managers in urban areas in many parts of the US have begun to monitor urban area and highway stormwater runoff for a variety of chemical constituents and pathogenic organism indicators. These studies are confirming the findings of similar types of monitoring efforts that were conducted in the 1960's as well as the US EPA's National Urban Runoff Program (NURP) studies conducted in the late 1970's and early 1980's that urban stormwater runoff contains elevated concentrations of a variety of chemical constituents that are of potential concern because of toxicity to aquatic life.

It has been known since the 1960's that several heavy metals, such as copper, lead, zinc and cadmium, are present in urban area street and highway runoff at concentrations that exceed US EPA water quality criteria/state standards in the runoff waters. These exceedances, therefore, could be considered "water quality impairments" under current federal and state regulatory requirements where the exceedance of a water quality standard in ambient waters for an NPDES permitted discharge is labeled, albeit inappropriately, a "use impairment" that requires control.

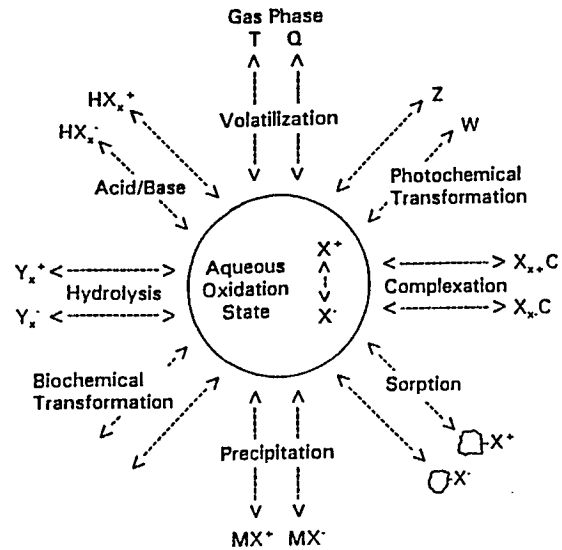
In the early 1990's, the state of California Water Resources Control Board and its regional water quality control boards worked with major urban stormwater dischargers (with populations greater than 100,000) to develop early, compared to most of the rest of the country, stormwater runoff NPDES permits. This situation has led to the development of data from a number of stormwater runoff monitoring programs. These programs have demonstrated that copper and several other chemical constituents are present in urban and highway stormwater runoff at concentrations above water quality standards in the South San Francisco Bay area. The Bay has been found to contain both total and dissolved copper concentrations above the site-specific copper standard (called "objective" in California) developed by the San Francisco Bay Regional Water Quality Control Board. This situation has led to the Bay being classified as "water quality limited" and has, in accord with current regulations, caused the regulatory agencies to develop the wasteload allocation for copper and Total Maximum Daily Loads (TMDL's) for the various sources of copper to the Bay.

Validity of US EPA Water Quality Criteria to Estimate Toxic Concentrations of Chemical

Criteria Assume Worst-Case Conditions - 100% Toxic/Available Forms and Chronic - Extended Periods of Exposure
Only Small Part of the Total Copper Toxic

Aqueous Chemistry and Toxicology of Copper in Marine Waters Such That Worst-Case Assumptions Over-Estimate Actual Toxicity

Aquatic Chemistry of Chemical Contaminants



Distribution Depends on Kinetics & Thermodynamics of Reactions in a Particular Aquatic System

Each Chemical Species Has Its Own Toxicity Characteristics
Many Forms Are Non-Toxic

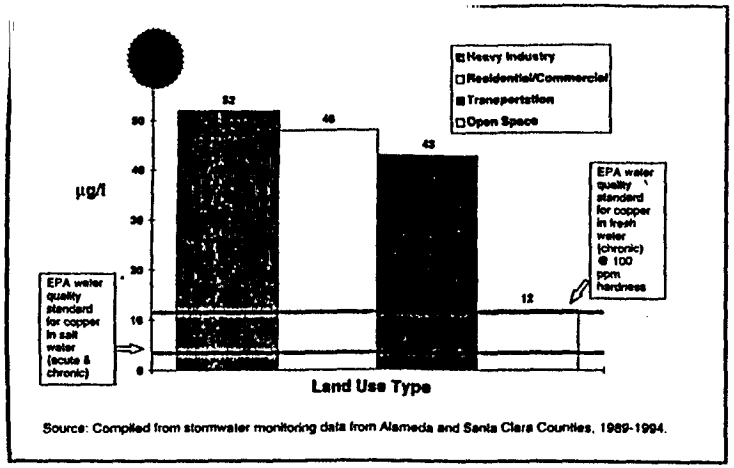


FIGURE 1
Average Storm Water Runoff Total Copper Concentrations in Two California Counties.

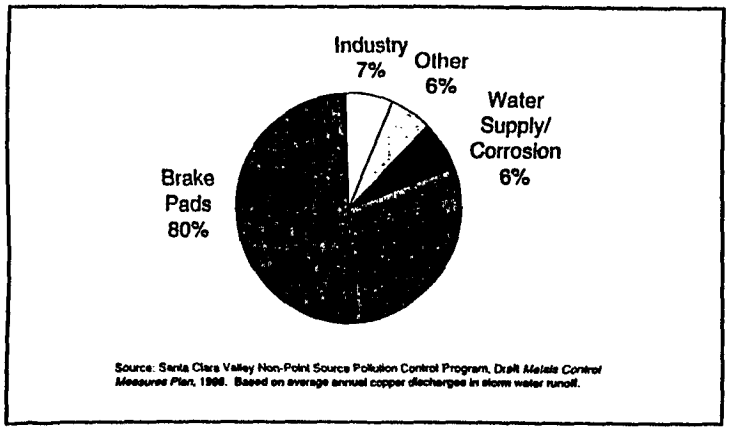


FIGURE 2
Urban Storm Water Copper Sources

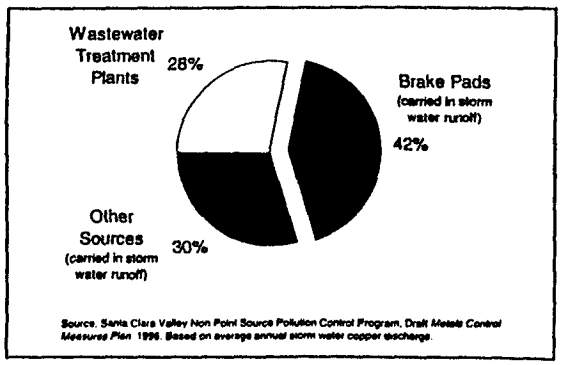


FIGURE 4
South Bay Copper Sources

Auto Brake Pad Copper Substitution Issues

Based on Current Information, Auto Brake Pad Copper Substitution is a Mis-Directed Effort

- Where is the Real Water Quality Use Impairment Due to Copper Exceedance of Water Quality Objectives?
  - Administrative
  - Will Disappear If Independent Applicability Policy Terminated

Substitute for Copper Could Cause Real Water Quality Problems

- Alternatives Not Properly Evaluated for Public Health and Environmental Impacts

Should Focus Water Pollution Control Resources on Finding Real, Significant Water Quality Use Impairment--i.e. Organophosphorus Pesticides

- Search for Problems Due to Copper in Auto Brake Pads
  - If Found, Implement Control After Proper Evaluation of Alternative Materials

Pollution Prevention

Removal of Copper from Auto Brake Pads Advocated As a "Pollution Prevention" Activity

- Pollution Is an Impairment of the Designated Beneficial Uses of a Waterbody
  - No Pollution Found for Copper Currently Present in San Francisco Bay Water and Sediments

Pollution Prevention Should Be Based On Pollution Control and Not Chemical Constituent Control

- Requires Comprehensive Investigation of Aquatic Chemistry and Toxicology of Potential Pollutants

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We need your support to form the Brake Pad Partnership.

In the 1980's, the U.S. Environmental Protection Agency and state agencies across the nation began to address water pollution from copper and other toxic metals as a top priority. Initially these efforts focused primarily on point sources, such as industrial operations and publicly owned waste water treatment facilities. As a result, significant reductions in pollutants from individual point sources were achieved and, in some cases, water quality improved substantially. However, many major water bodies continue to fall far below water quality objectives. To realize further significant gains in water quality, regulatory agencies, industry, and environmental organizations are broadening their attention to water pollution from nonpoint sources.

Copper pollution is a nationally significant problem occurring in major water bodies such as: the Chesapeake Bay, the Delaware Estuary, New York-New Jersey Harbor, and the San Diego Bay. Recent studies on the San Francisco Bay demonstrate the relative importance of nonpoint sources, and automotive brake pads, in particular, to controlling copper levels. Controlling copper levels in brake pads could potentially reduce copper flowing to surface waters around the nation.

Common Ground for the Environment is requesting your support and participation in convening a national Brake Pad Partnership. The goal of the Partnership is to identify and implement a voluntary, business solution to reduce the levels of copper entering water bodies from brake pads.

A partnership presents the opportunity to address the issue of copper from brake pads in a manner that can benefit industry, government, and environmental concerns. Benefits include:

- Moving beyond traditional command and control regulation toward a cooperative, voluntary solution;
- Anticipating environmental concerns through a proactive approach that directly incorporates market, economic, and technical issues;
- Meeting or creating market preferences in lieu of regulatory requirements.

Common Ground is prepared to bring together stakeholders in this process to:

- Better define and understand the environmental problem;
- Identify the best means of approaching that problem; and
- Develop a voluntary business solution to that problem.

If you have any questions regarding this effort, or would like to send a letter of support, please contact Greg Schwartz, Common Ground for the Environment, at Sustainable Conservation: 415-288-0380.

Solving the Copper Problem: The Brake Pad Partnership

Kelly D. Moran, Ph.D., City of Palo Alto

Elevated copper levels are a priority concern for storm water runoff. Copper is toxic to aquatic life in very low concentrations (parts per billion). Runoff copper levels typically exceed both acute and chronic water quality criteria for both fresh water and salt water (see Figure 1).[1,2] The Nationwide

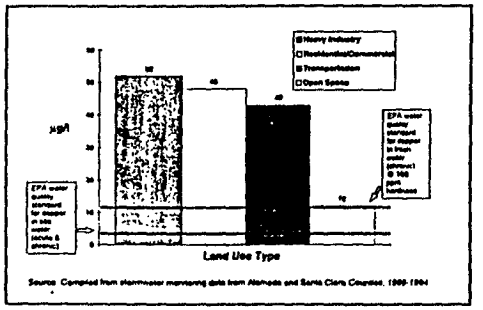

FIGURE 1
Average Storm Water Runoff Total Copper Concentrations in Two California Counties.

Urban Runoff Program found that copper was one of the biggest concerns for urban storm water runoff. [2]

Urban storm water runoff is a major contributor of copper to surface water bodies near urban areas. Many of the nation's major water bodies, particularly estuaries, exceed water quality standards for copper.[3] The United States Environmental Protection Agency (U.S. EPA) has evaluated available data from its STORET database regarding copper levels in U.S. surface waters and has concluded that copper exceeds water quality criteria in many watersheds, especially estuaries, around the country.[4] The contribution of copper from storm water runoff has been investigated in the south San Francisco Bay, where copper levels exceed water quality criteria [5] and urban storm water runoff is the major source of copper discharge.[6]

Studies for the Santa Clara Valley Nonpoint Source Pollution Control Program conducted by Woodward-Clyde Associates have investigated sources of copper in urban storm water runoff [6, 7] While these studies are based on somewhat limited data, they shown that automobile brake pads are probably the largest single source of copper in urban storm water runoff (see Figure 2).[6] The Palo Alto Regio Water Quality Control Plant has found significant amou of copper in sewer discharges from car washes and vehi service facilities, and in storm water inflow to the sewer s tem. Much of this copper, which contributes to violation the wastewater treatment plant's copper effluent limitati may be from brake pads.[8]

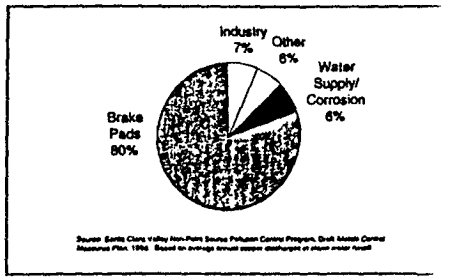

FIGURE 2
Urban Storm Water Copper Sources

Some, but not all, brake pads contain copper and o heavy metals. Copper content can vary from manufact to manufacturer and even among pads made by the s manufacturer. The range of copper content in a group o disc brake pads analyzed by the Santa Clara Valley Non Source Pollution Control Program was from essentially ze 20.5 percent.[7]

Braking, which forces disc brake pads against a r rotor mounted behind the wheel of a car or truck (see Fi 3), releases fine dust from wear of the pad materials int environment. Once brake pad dust comes off a car, it ca on a road or travel through the air. Either way, the dust c deposited into or be washed into surface water bodi most areas, storm drains flow directly to surface water ies without wastewater treatment.

Preventing pollution by eliminating the use of cop brake pads would be substantially more effective attempting to control this pollution once dispersed i environment. Street sweeping, while costly, is not partic effective at collecting fine particulate matter like the m released from brake pad wear. Similarly, other operation structural controls, while costly, have not been demonst

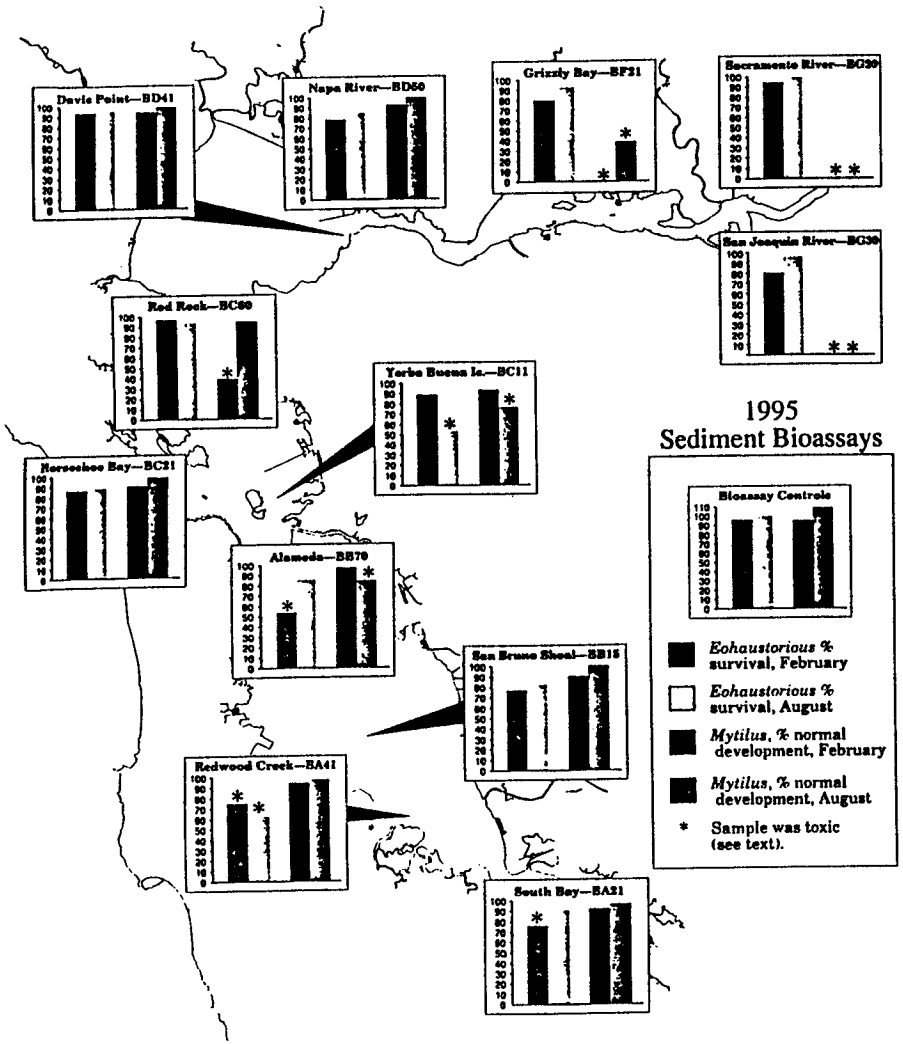

Figure 14. Chart showing results of sediment bioassays at selected RMP stations.

San Francisco Bay Sediment Copper Issues

San Francisco Bay Sediments, In General, Do Not Contain Elevated Concentrations of Copper

Average Copper in California Soils – 50 mg/kg

San Francisco Bay Shallow Sediments Stirred into the Water Column with Each Storm

Will Not Achieve Water Quality Standards with Only One Exceedance Every Three Years, Even if All Copper Inputs to the Bay Terminated

Phased Approach for Copper Control for San Francisco Bay Technically Invalid and Could Result in Expenditures in Excess of $1 Billion to Try to Meet Regulatory Requirements, Ultimately Failing to Achieve Them

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Toxicity of San Francisco Bay Sediments Not Related to Copper Content

* Exceedance of Copper Water Quality Objective is Not Causing Discernible Water Quality Impairment in Bay Waters and Sediments

DESIGNING FOR CLEAN WATER

BRAKE PAD PARTNERSHIP

Copper Regulatory Issues

Copper of Concern Because of Potential Toxicity to Aquatic Life

National Criterion Based Principally on Copper Toxicity to *Mytilus edulis* Larvae

San Francisco Bay Water with "Excessive" Copper Non-Toxic to *Mytilus edulis* Larvae

Where Is the Water Quality Problem?
- "Administrative" Exceedance - Not Related to Water Quality Use Impairment
- Over-Regulation

Copper in San Francisco Bay Water in Non-Toxic, Non-Available Form

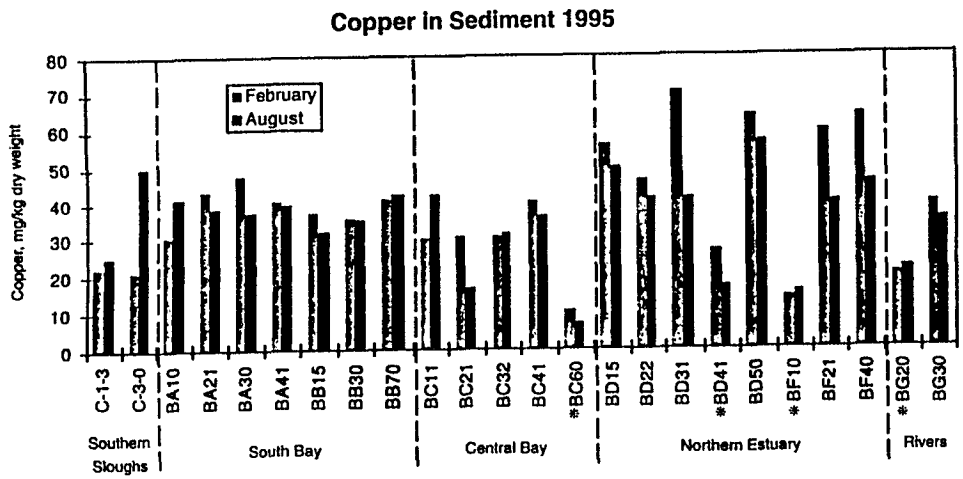
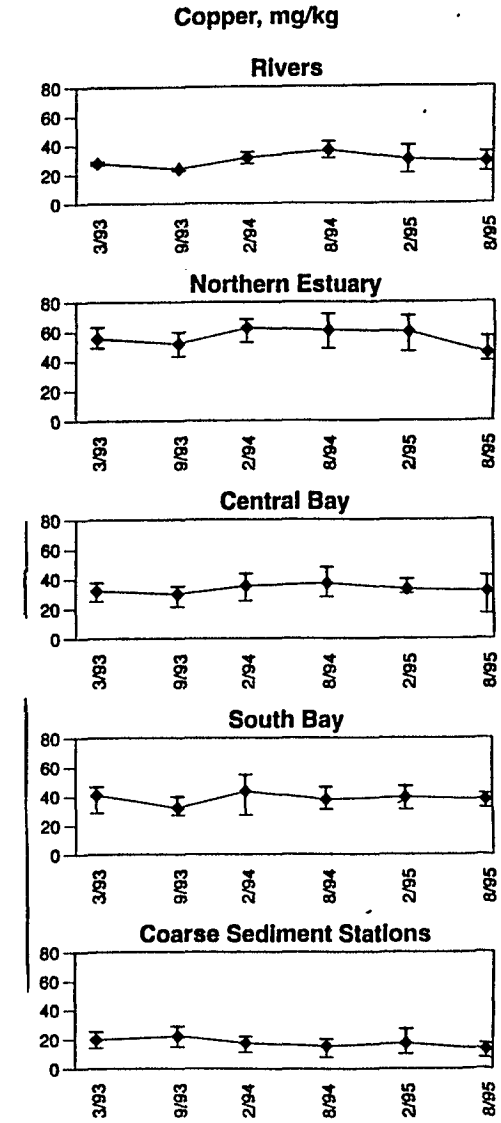


Figure 4. Copper (Cu) concentrations in sediment in parts per million, dry weight (ppm) at 24 RMP stations sampled in February and August of 1995.



RMP

Regional Monitoring Program for Trace Substances

1995 Annual Report

A Cooperative Program Managed and Administered by the San Francisco Estuary Institute

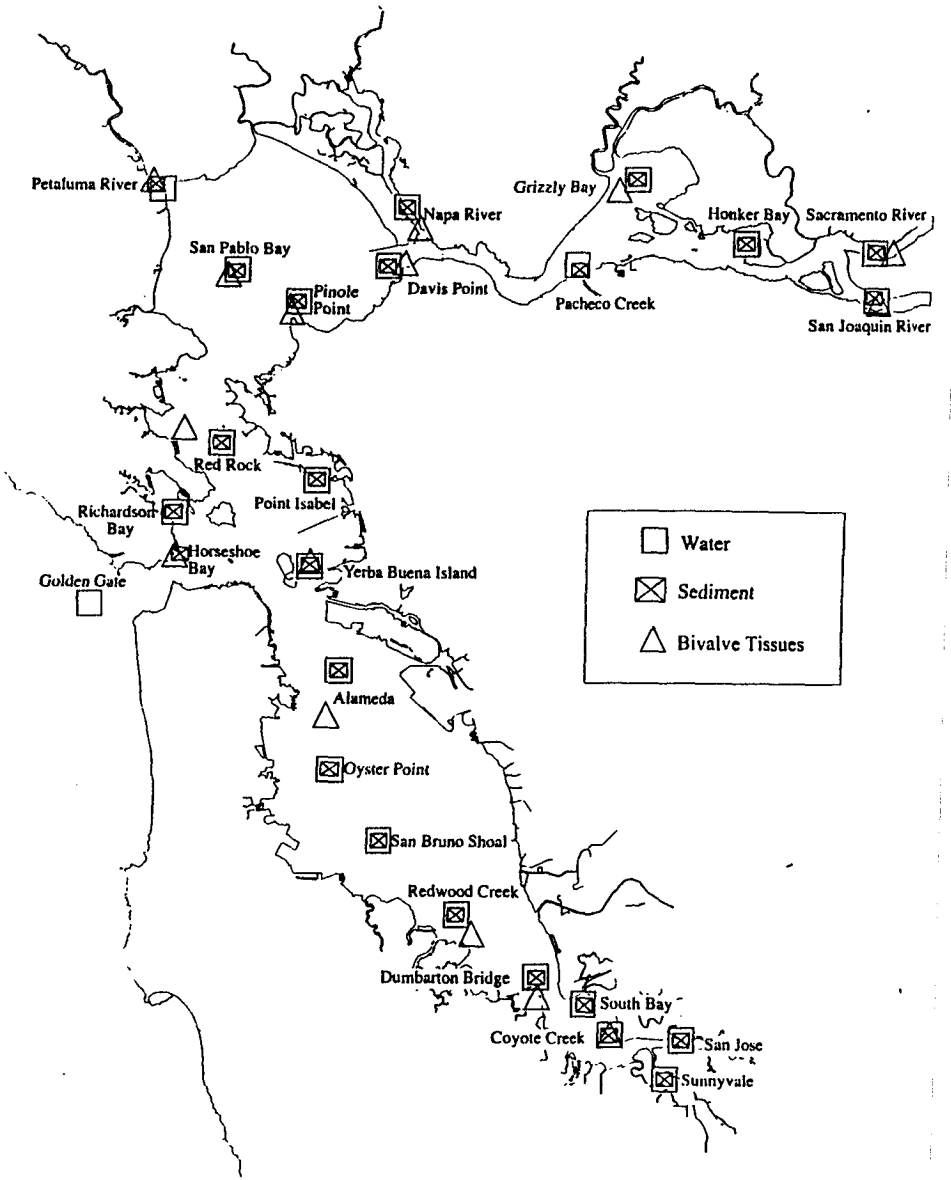


Figure 1. Location of 1995 Regional Monitoring Program stations.

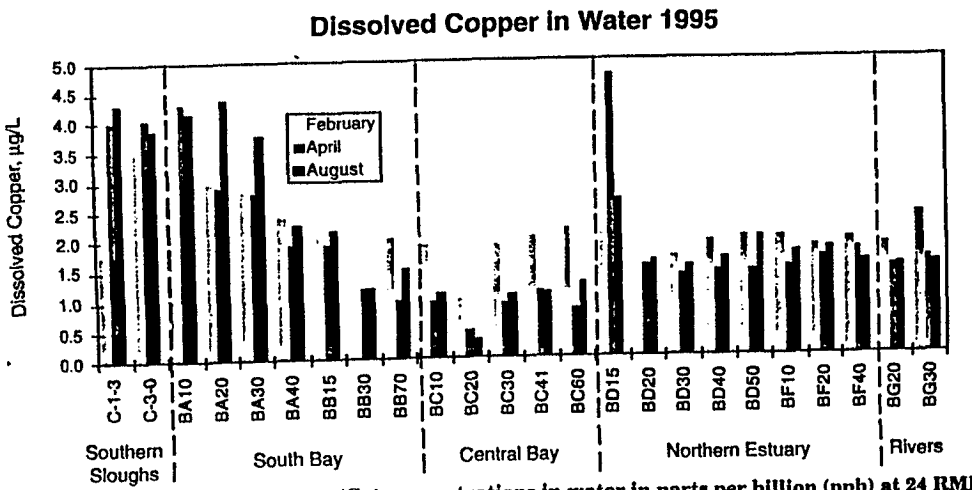


Figure 10. Dissolved copper (Cu) concentrations in water in parts per billion (ppb) at 24 RMP stations sampled in February, April, and August of 1995.

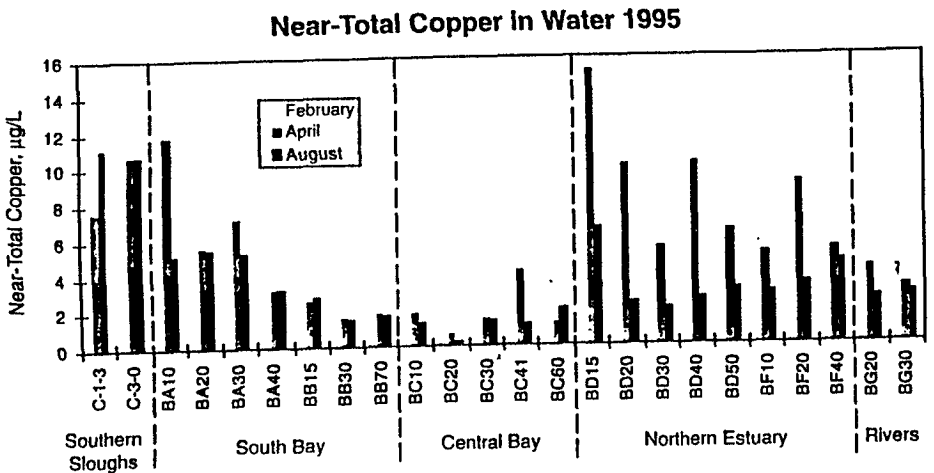
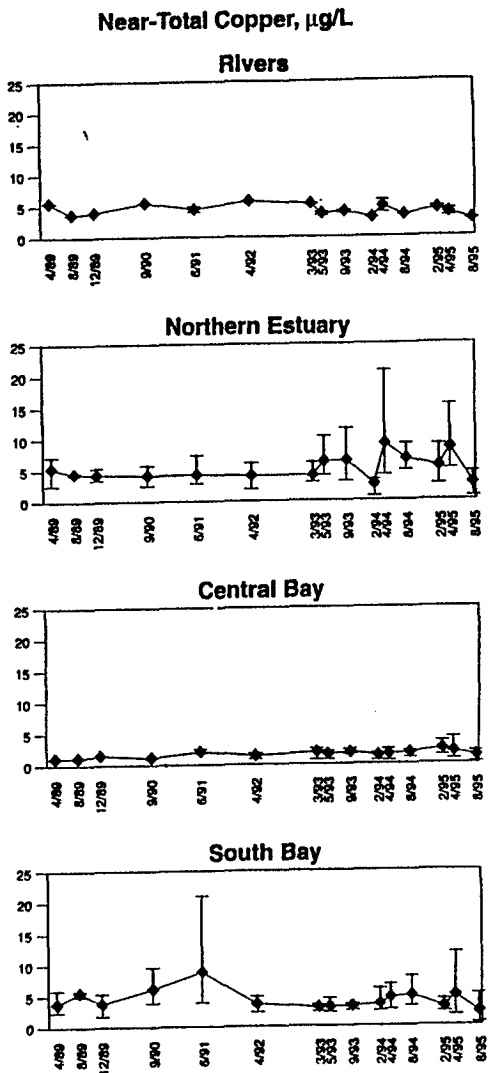


Figure 11. Near-total copper (Cu) concentrations in water in parts per billion (ppb) at 24 RMP stations sampled in February, April, and August of 1995.



Figures 64 and 65. Plots of average chromium and copper concentrations (parts per billion, ppb) in water in each Estuary reach from 1989–1995.

Clean Water Act Requirements

Exceedance of Water Quality Standard for More than Once in Three Years

▼

Water Quality Limited

▼

Waste Load Allocation

▼

Total Maximum Daily Loads

▼

Phased Approach

▼

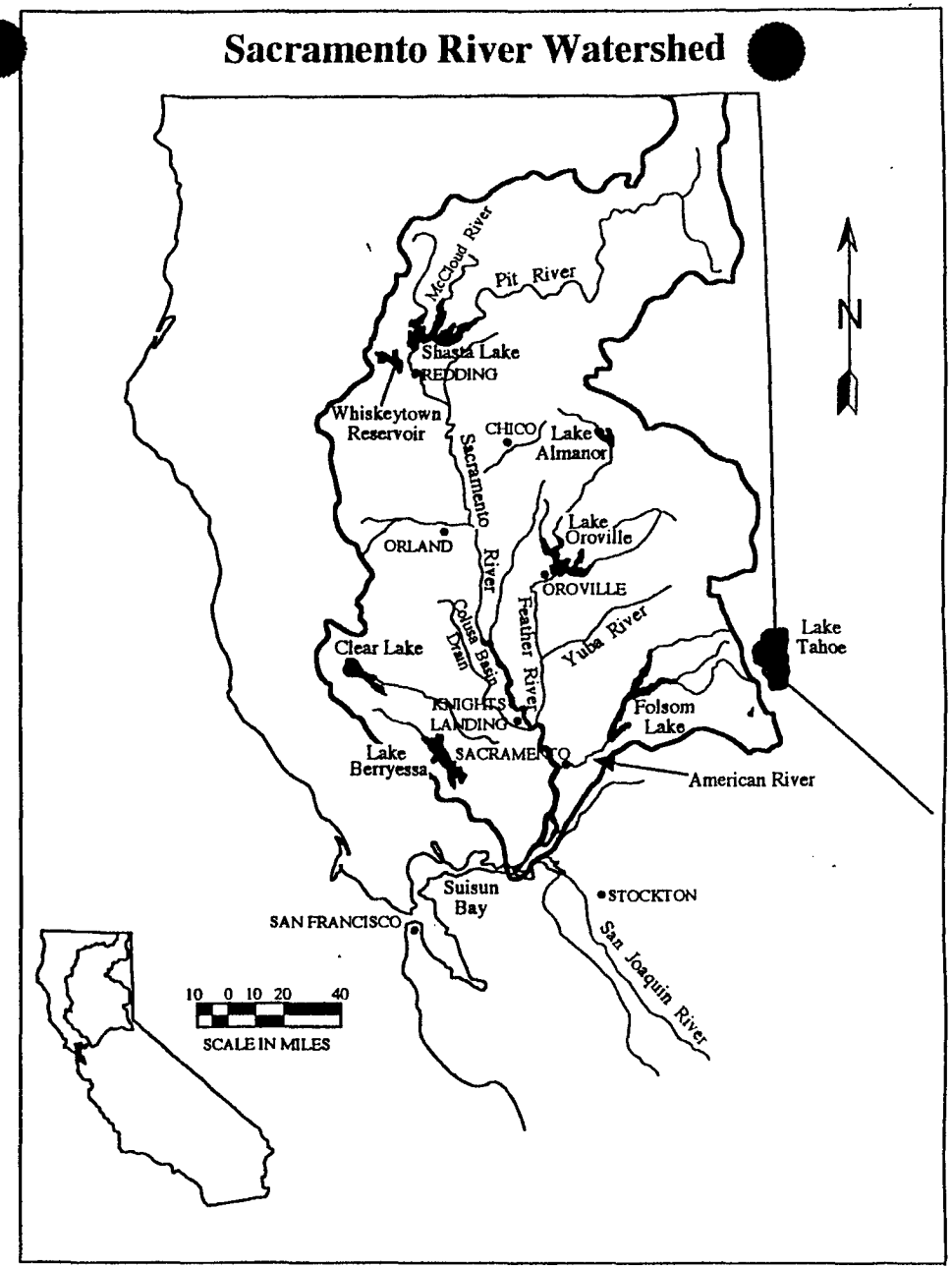
If the Phase 1 Load Reductions Do Not Result in Achieving Site-Specific Water Quality Objective So There Is No More than One Exceedance of Any Magnitude Every Three Years, Establish New TMDLs for Phase 2

Mass Loading Limits for Copper by 2003

Stormwater Runoff	20%
Riverine Inputs to Bay	25%
Municipal and Industrial Wastewaters	25%

(SFRWQCB, 1993)

Not Based on Copper Load Bay Concentration Response Relationship



Water Quality Criteria for Copper in Marine Waters

National Toxics Rule - December 1992
National Cu Criteria For:
Salt water 1 Hour Average 2.9 µg/L
4 Day Average 2.9 µg/L

SFRWQCB Site-Specific Objective 1995
Total Copper Objective 4.9 µg/L/hr average
Based on Water Effect Ratio

US EPA 1995 National Toxics Rule
Convert Salt Water 1 Hr Average Total Copper to Dissolved Copper
Multiplied by 0.83

San Francisco Bay Dissolved Copper Site-Specific Objective is 4.1 µg/L

San Francisco Bay Waters in 1995 Showed Exceedances of the Total and Dissolved Copper Site-Specific Objectives

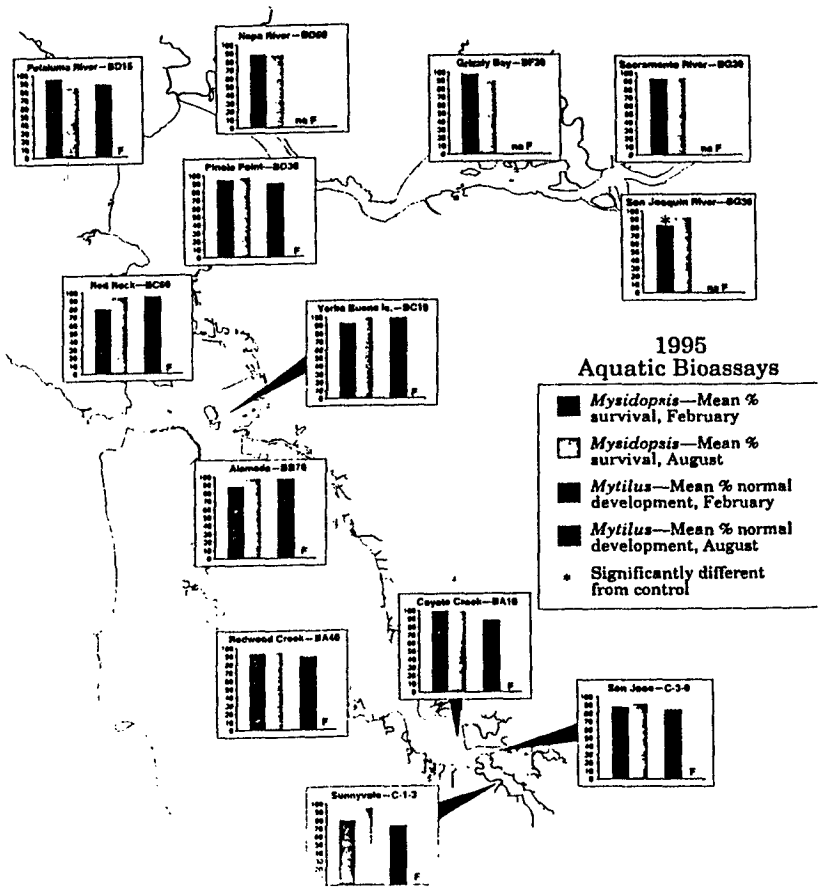


Figure 36. Chart showing results of aquatic bioassays at selected RMP stations.

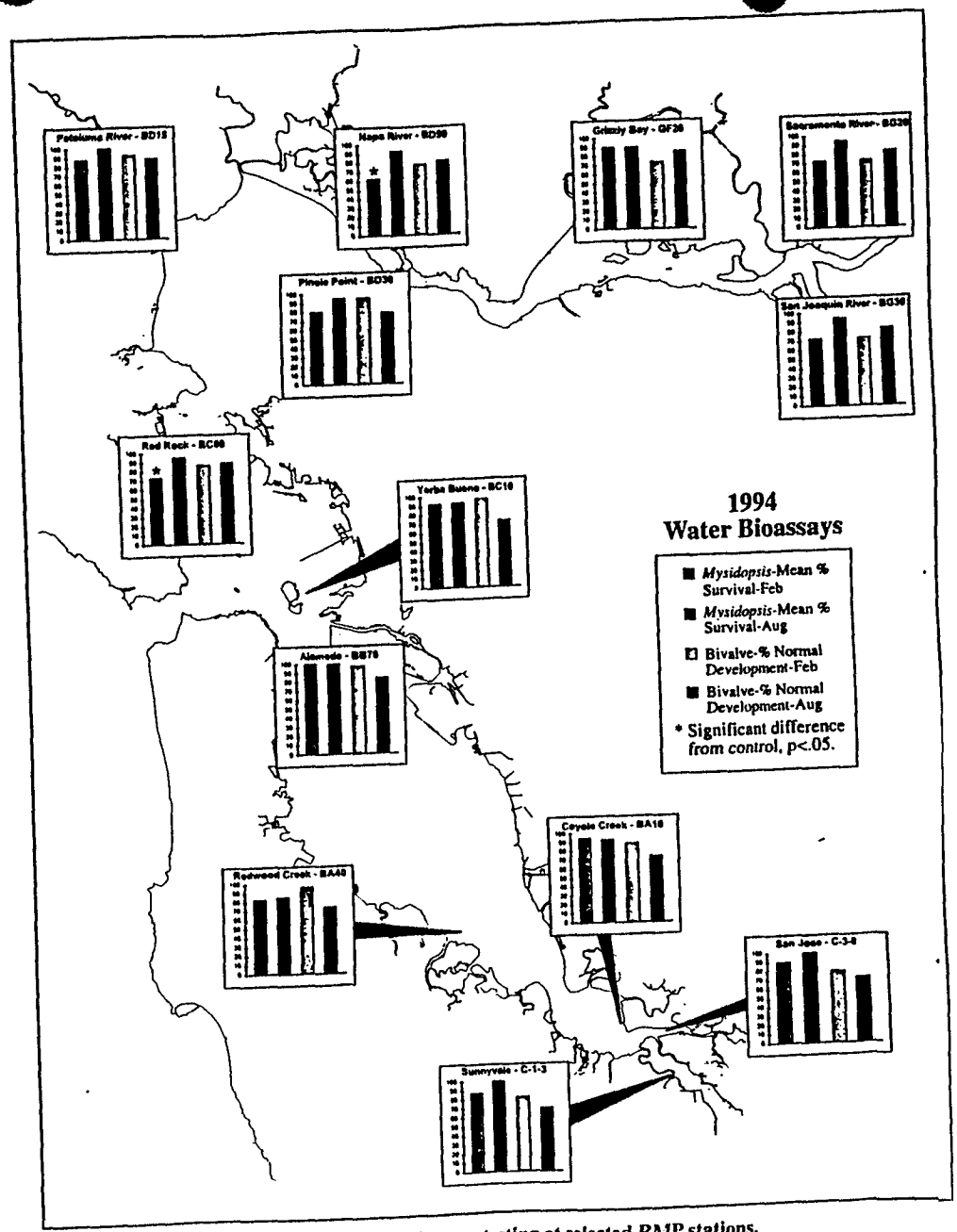


Figure 27. Chart showing results of water bioassay testing at selected RMP stations.

D—043738

Regulating Copper in San Francisco Bay: Importance of Appropriate Use of Aquatic Chemistry and Toxicology

G. Fred Lee and A. Jones-Lee. *G. Fred Lee & Associates, 27298 E. El Macero Drive, El Macero, CA 95618-1005.*

Introduction. In the late 1980's, it was found that the concentrations of copper in San Francisco Bay waters exceeded the US EPA's national water quality criterion of 2.9 µg/L. With the implementation of the National Toxics Rule, the state of California Water Resources Control Board (WRCB) and the San Francisco Regional Water Quality Control Board (SFRWQCB) are required to declare San Francisco Bay as a water quality-limited waterbody because of the "excessive" copper present in the Bay waters relative to the US EPA water quality criterion. This caused the SFRWQCB to develop a wasteload allocation and total maximum daily loads (TMDLs) for various copper dischargers to the Bay and its tributaries, including stormwater runoff from urban area streets and highways. The SFRWQCB conducted Water Effects Ratio (WER) studies that developed a site-specific copper objective of 4.9 µg/L.

Using clean sampling and analytical techniques, San Francisco Bay waters have been found to contain total and dissolved copper in excess of the site-specific water quality criterion-standard. Therefore, San Francisco Bay is still "water quality limited" and, in accord with current US EPA policy, must initiate a TMDL program to limit the copper input to the Bay so the concentrations of dissolved copper in Bay waters do not exceed the site-specific water quality standard (objective).

One of the sources of copper for San Francisco Bay is stormwater runoff from urban area streets and highways. It was estimated by the Santa Clara Valley Nonpoint Source Pollution Control Program that 35% of the total copper entering South San Francisco Bay is derived from auto brake pads in stormwater runoff from urban area streets and highways. This situation has caused some environmental groups and others to call for a national ban on the use of copper in automobile brake pads. Such a ban appears to be readily feasible since the US auto manufacturers (GM, Ford and Chrysler) do not use brake pads that contain copper. The City of Palo Alto and an environmental group, Common Ground for the Environment and Sustainable Conservation, have initiated an effort to cause automobile brake pad manufacturers to "voluntarily" stop using copper in automobile brake pads (1). Lee and Jones-Lee (2) question the appropriateness of any change in copper brake pad concentrations based on the extensive studies over the past three years on San Francisco Bay waters and sediments that have shown that the "excessive" copper in the waters is in a non-toxic, non-available form. Further, as reported by B. Thompson (3), there is an inverse relationship between the copper concentrations in San Francisco Bay sediments and sediment toxicity.

Inappropriate Regulatory Approaches. In the early 1990's, the US EPA, without public review, adopted the Independent Applicability Policy which requires that chemically-based water quality criteria/standards have to be met in the receiving waters for NPDES-permitted discharges, even if appropriately conducted studies of these waters show that the chemically-based standards are over-protective. Lee and Jones-Lee (4) have discussed the inappropriate nature of the US EPA's Independent Applicability Policy which leads to significant over-regulation of chemical constituents, such as copper in San Francisco Bay. As they point out, the problem with copper in San Francisco Bay is an administrative problem in which the current regulatory approaches do not adequately and reliably consider the aqueous environmental chemistry of copper and its toxicology in Bay waters. The current administration of the US EPA recognizes this problem and, as part of its "Advanced Notice of Proposed Rulemaking" (5), has proposed to address it as part of revising the Agency's water quality standards regulations.

Proposed Regulatory Approach for Potentially Toxic Heavy Metals and Other Constituents. It is apparent from the San Francisco Bay copper situation that the US EPA's current regulatory approach for potentially toxic chemicals, such as heavy metals, has significant tech[illegible]efficiencies that can readily lead to substantial waste of public and private funds in m[illegible]g chemical constituents in urban area and highway stormwater runoff. This paper presents an alternative regulatory approach to the current US EPA approach for protecting aquatic ecosystems from the adverse impacts of potentially toxic heavy metals and others constituents which more appropriately than is done today incorporates site-specific biogeochemical information into water quality/adverse impacts on ecosystems problem definition and management than is done under the current US EPA regulations. The current regulatory approach of establishing a national water quality criterion which is to be used by states as a standard leads to significant over-regulation of potentially toxic chemicals. The Agency's Water Effects Ratio adjustment of the national criterion fails to properly incorporate the aquatic chemistry and toxicology that must be considered in establishing appropriate discharge limits from wastewater inputs, stormwater runoff and from atmospheric inputs that will protect aquatic ecosystems and the designated beneficial uses of waterbodies without significant, unnecessary expenditures for chemical constituent control. Lee and Jones-Lee (6) discuss the need for an alternative regulatory approach for regulating potentially toxic chemicals in aquatic systems.

Evaluation Monitoring. The authors have developed and are implementing an alternative regulatory approach for managing urban area and highway stormwater runoff-associated chemical constituents that can lead to aquatic life toxicity or excessive bioaccumulation of hazardous chemicals in aquatic life tissue that represent health hazards to those who use the organisms as food. This approach (Evaluation Monitoring) (7) utilizes the monitoring funds that are typically used for end-of-the-pipe/edge-of-the-pavement monitoring to define what real water quality use impairments are occurring in the receiving waters for the stormwater runoff. Where such problems are found, through appropriate aquatic chemistry and toxicology forensic investigations, the cause of the problems is determined, the source of the constituents responsible for the problems is identified and, in a cooperative effort with regulatory agencies and other stakeholders in a watershed-based water quality management program, control programs are implemented to control the constituents responsible for the water quality problem at the source. The Evaluation Monitoring approach provides guidance on where there is need for biogeochemical research to help identify real water quality problems and develop technically valid, cost-effective control of them. This paper summarizes the need for an alternative regulatory approach based on the copper situation in San Francisco Bay. It also presents the Evaluation Monitoring approach for addressing water quality problems due to potentially toxic heavy metals and other constituents.

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(1) Common Ground for the Environment and City of Palo Alto. 1996. Copper, Brake Pads, & Water Quality: Briefing Packet. Sustainable Conservation, San Francisco, CA.

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(3) Thompson, B. 1996. Sediment Toxicity in the San Francisco Estuary. Presentation at the Third Biennial State of the Estuary Conference, October, San Francisco, CA.

(4) Lee, G. F. and Jones-Lee, A. 1995. Independent Applicability of Chemical and Biological Criteria/Standards and Effluent Toxicity Testing. The National Environmental Journal, 5(1):60-63, Part II, "An Alternative Approach," 5(2):66-67.

(5) US EPA. 1996. Interim Draft Advance Notice of Proposed Rulemaking on the Water Quality Standards Regulation at 40 CFR 131. US Environmental Protection Agency, Office of Water, Washington, D.C.

(6) Lee, G. F. and Jones-Lee, A. 1995. Appropriate Use of Numeric Chemical Water Quality Criteria. Health and Ecological Risk Assessment. 1:5-11.

(7) Lee, G. F. and Jones-Lee, A. 1996. Evaluation Monitoring for Stormwater Runoff Monitoring and BMP Development. Report of G. Fred Lee & Associates, El Macero, CA.

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El Macero, CA

Regulation of Copper and Other Heavy Metals in Urban Area Street and Highway Stormwater Runoff

Need for Biogeochemistry and Aquatic Toxicology to Develop Technically Valid, Cost-Effective Regulation of Heavy Metals

Presented at Fourth International Conference on the Biogeochemistry of Trace Elements, Berkeley, CA, June (1997).